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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/538,316	11/04/2005	Steven Brent Assa	57.0474 US PCT	4046

37003 7590 09/25/2007

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EXAMINER	
JANAKIRAMAN, NITHYA	

ART UNIT	PAPER NUMBER
2123	

MAIL DATE	DELIVERY MODE
09/25/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/538,316	ASSA ET AL.	
	Examiner	Art Unit	
	Nithya Janakiraman	2123	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *13 June 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-44* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-44* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *13 June 2005* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *8/26/2005*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

This action is in response to the application filed on 6/13/2005, which is a national stage entry of PCT/GB03/05395, with international filing date 12/11/2003. Foreign priority date of 12/21/2002 is acknowledged. Claims 1-44 are presented for examination.

Claim Rejections - 35 USC § 101

35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

1. Claims 1-35 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.

2. Claim 1 recites "processing earth model data" as the final step of the recited method. The step of "processing" produces "processed data" which is not a useful, concrete, and tangible result for the purposes of 35 U.S.C §101 statutory subject matter. The claim, as written, is therefore not limited to a practical application and is nonstatutory. Claims 2-35 are rejected by virtue of their dependency.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claim 28 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

4. Claim 28 recites "...wherein the plurality of subdivisions are generated such that the number of parameters in each subdivision times the number of subdivisions is substantially less than would be need using a faceted representation method". The term "substantially less" in claim 28 is a relative term which renders the claim indefinite. The term "substantially" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. In addition, there is no recitation as to what would be a normal number for "parameters times subdivisions" in a faceted representation model.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 1-14, and 17-44 rejected under 35 U.S.C. 102(e) as being anticipated by US Patent 6,480,790, Calvert et al. (hereinafter Calvert).

6. *Claim Interpretation:* Math World defines a "symmetry group" as a group of symmetry-preserving operations, i.e. rotations, reflections, and inversions. It is well known in the art, as shown in Wikipedia, that a cube is an example of a symmetry group containing a set of diffeomorphisms, in that under transformation a cube (shown in Figures 2 and 3 of Calvert) would occupy the same points in space-time.

7. Regarding claim 1, Calvert discloses:

A method for processing data used for hydrocarbon extraction from the earth comprising the steps of:

receiving sampled data representing earth structures (Figure 1, **106**);

identifying one or more symmetry transformation groups from the sampled data (Paragraph [0011] of the disclosure defines "symmetry transformation groups" as "preferably a set of diffeomorphisms that act on a topologically closed and bounded region in space-time such that under transformation the region occupies the same points in space"; Calvert discloses this transformation, or mapping, in column 6, lines 51-60, "generating a tentative geologic model of the subsurface earth volume, the tentative geologic model comprising a three-dimensional array of contiguous model blocks...positions for the one or more geologic interfaces"; Figures 2 and 3 depict the blocks, or cubes.);

identifying a set of critical points from the sampled data (column 10, lines 40-49, "...replaced by a three-dimensional array of discrete model points. Preferably, at least a portion of the discrete model points correspond to sample points in a three-dimensional seismic data volume for subsurface earth volume");

generating a plurality of subdivisions of shapes the subdivisions together representing the earth structures, the generation being based at least in part on the set of identified critical points and the symmetry transformation groups (column 6, lines 51-67; column 10, lines 40-49, "...replaced by a three-dimensional array of discrete model points. Preferably, at least a portion of the discrete model points correspond to sample points in a three-dimensional seismic data volume for subsurface earth volume"); and

processing earth model data using the generated subdivision of shapes (Figure 1, **114**).

8. *Claim Interpretation:* Math World defines a "symmetry group" as a group of symmetry-preserving operations, i.e. rotations, reflections, and inversions. It is well known in the art, as shown in Wikipedia, that a cube is an example of a symmetry group containing a set of diffeomorphisms, which under transformation occupies the same points in space.

9. Regarding claim 2, Calvert discloses:

A method according to claim 1 wherein the identified symmetry transformation group is a set of diffeomorphisms that act on a topologically closed and bounded region in space-time such that under transformation said region occupies the same points in space (Figures 2 and 3 depict the blocks, or cubes).

10. Regarding claim 3, Calvert discloses:

A method according to claim 1 wherein each of the identified symmetry transformation groups corresponds to a plurality of shape families (column 1, line 30, "model blocks (cells)").

11. Regarding claim 4, Calvert discloses:

A method according to claim 3 wherein each of the plurality of shape families comprises a set of predicted critical points (column 10, lines 40-49, "...replaced by a three-dimensional array of discrete model points. Preferably, at least a portion of the discrete model points correspond to sample points in a three-dimensional seismic data volume for subsurface earth volume").

12. Regarding claim 5, Calvert discloses:

A method according to claim 4 wherein the step of generating subdivisions comprises selecting a shape family from the plurality of shape families that corresponds to the identified symmetry transformation group, said selecting being based on closeness of correspondence between the identified critical points from the sampled data and the predicted critical points of the selected shape family (column 1, lines 42-44; "any shape may be used").

13. Regarding claim 6, Calvert discloses:

A method according to claim 5 wherein each shape family has an associated set of symmetry transformation group orbits, some of the orbits being associated with critical points and other orbits being associated with distinguished Gaussian curvature values (Orbits are disclosed in the concept of geologic interface criteria: column 12, lines 4-24, "...in addition to criteria that define the spatial attributes (e.g. position, smoothness, curvature, etc.) of the geologic interfaces...Typical examples of geologic interface criteria include limits on the extent a geologic interface may be moved vertical or laterally... and degree of smoothness required in the geologic interfaces"; column 10, lines 40-49, "...replaced by a three-dimensional array of

discrete model points. Preferably, at least a portion of the discrete model points correspond to sample points in a three-dimensional seismic data volume for subsurface earth volume").

14. Regarding claim 7, Calvert discloses:

A method according to claim 6 wherein each symmetry transformation group orbit of the selected shape family is associated with orbit information that specifies whether the orbit contains a predicted critical point and value of the Gaussian curvature of a point in the orbit (column 3, lines 5-8).

15. Regarding claim 8, Calvert discloses:

A method according to claim 7 wherein the orbit information from the set of symmetry transformation group orbits associated with the selected shape family is applied to the sampled data thereby generating a unique specification of a shape from the selected shape family (column 12, lines 4-24, "...rules for modeling are specified. The preferred mode of operation is to incorporate as many rock-property variables and criteria as possible in order to remove ambiguity and enhance uniqueness...").

16. Regarding claim 9, Calvert discloses:

A method according to claim 8 wherein each of the plurality of subdivisions of shapes is generated by identifying a part of the uniquely specified shape that corresponds to the sampled data (column 6, lines 57-60).

17. Regarding claim 10, Calvert discloses:

A method according to claim 9 wherein the identified parts of the uniquely specified shapes are assembled, thereby generating a representation of the earth structures (Figure 1, **120**).

18. Regarding claim 11, Calvert discloses:

A method according to claim 10 wherein the generated representation is continuous (Figure 2, **212**).

19. Regarding claim 12, Calvert discloses:

A method according to claim 11 wherein the generated representation is smooth (Figure 2, **212**).

20. Regarding claim 13, Calvert discloses:

A method according to claim 9 wherein the uniquely specified shapes are specified using differentiable functions including one or more of the following types: surfaces derived from conic sections, splines, general polynomials and trigonometric functions (column 14, lines 23-35).

21. Regarding claim 14, Calvert discloses:

A method according to claim 1 wherein the sampled data is smoothed prior to said steps of identifying critical points and identifying one or more symmetry transformation groups (column 14, lines 23-35, "Several statistics may be used for the smoothness criterion").

22. Regarding claim 17, Calvert discloses:

A method according to claim 1 wherein the earth model data is geologic data, geophysical data, petrophysical data, mechanical earth model data and/or reservoir fluid flow data (column 1, lines 10-17).

23. Regarding claim 18, Calvert discloses:

A method according to claim 1 wherein earth model data is processed such that earth models are updated, alternative versions of existing earth models are created, time-lapse earth models are generated and/or the earth model data is distributed to other earth models or other applications (Figure 1, **112**).

24. Regarding claim 19, Calvert discloses:

A method according to claim 1 wherein the sampled data represents sampled physical structure and material properties of the earth structures (Figure 1, **106**).

25. Regarding claim 20, Calvert discloses:

A method according to claim 1 wherein said step of processing earth model data comprises making predictions of fluid flow though at least some of the earth structures and wherein the altered activity is altering the rate of extraction based on said predictions (column 13, line 2).

26. Regarding claim 21, Calvert discloses:

A method according to claim 1 wherein said step of processing earth model data comprises predicting the likelihood of structural failure of a wellbore though at least some of the earth structures and wherein the altered activity is altering the drilling of the wellbore based on the predicted likelihood of failure (column 17, lines, 23-32).

27. Regarding claim 22, Calvert discloses:

A method according to claim 1 wherein said step of processing earth model data comprises communicating geologic information relating to at least some of the earth structures between a first geometrical representation and a second geometrical representation of the earth structures (Figure 1, **112**, "update").

28. Regarding claim 23, Calvert discloses:

A method according to claim 1 wherein said step of processing earth model data comprises aggregating information from a plurality of geometrical representations of the earth structures and wherein the altered activity is based at least in part on the aggregated information (Figure 1, **106**).

29. Regarding claim 24, Calvert discloses:

A method according to claim 1 wherein said step of processing earth model data comprises constructing an earth model to a user specified error tolerance using the generated subdivision of shapes (Figure 1, **120**).

30. Regarding claim 25, Calvert discloses:

A method according to claim 1 wherein each of the plurality of subdivisions of shapes is generated by identifying a part of a uniquely specified shape that corresponds to the sampled data (Figures 2A, 2B).

31. Regarding claim 26, Calvert discloses:

A method according to claim 1 wherein the step of generating a plurality of subdivisions comprises the steps of:

analyzing curvature of the sampled data thereby generating a shape index field; and identifying functions that fit the shape index field (Figures 2A and 2B).

32. Regarding claim 27, Calvert discloses:

A method according to claim 26 wherein the functions are differentiable (column 10, lies 1-3).

33. Regarding claim 28, Calvert discloses:

A method according to claim 1 wherein the plurality of subdivisions are generated such that the number of parameters in each subdivision times the number of subdivisions is substantially less than would be needed using a faceted representation method (Figures 2A and 2B).

34. Regarding claim 29, Calvert discloses:

A method according to claim 1 wherein the plurality of subdivisions are generated such that they are more numerically stable than third order or higher representation (Figures 2A and 2B).

35. Regarding claim 30, Calvert discloses:

A method according to claim 1 wherein the sampled data is a faceted representation of the earth structures (Figures 2A and 2B).

36. Regarding claim 31, Calvert discloses:

A method according to claim 30 wherein the faceted representation is a triangle mesh (column 2, line 22).

37. Regarding claim 32, Calvert discloses:

A method according to claim 30 wherein the faceted representation is a grid (column 2, line 22).

38. Regarding claim 33, Calvert discloses:

A method according to claim 1 wherein the sampled data is data measured with seismic acquisition equipment (Figure 1, **106**).

39. Regarding claim 34, Calvert discloses:

A method according to claim 33 wherein said steps of receiving, identifying one or more symmetry transformation groups, identifying a set of critical points and generating a plurality of

subdivisions of shapes are preformed at or near the location where the sample data is measured (Figure 1).

40. Regarding claim 35, Calvert discloses:

A method according to claim 34 wherein said step of processing earth model data is performed in one or more locations remote from the location where the sample data is measured (column 1, lines 10-17).

41. Regarding claim 36, Calvert discloses:

A system for improved extraction of hydrocarbons from the earth comprising:

a storage system adapted to receive and store sampled data representing earth structures (figure 1, **106**);

a processing system adapted to identify one or more symmetry transformation groups from the sampled data, identify a set of critical points from the sampled data, and generate a plurality of subdivisions of shapes the subdivisions together representing the earth structures, the generation being based at least in part on the set of identified critical points and the symmetry transformation groups (column 1, lines 10-17);

an earth model processing system adapted to processes earth model data using said generated subdivision of shapes (Figure 1, **114**); and

an interface to output the processed earth model data to an operator (column 1, liens 10-17).

42. Regarding claim 37, Calvert discloses:

A system according to claim 36 wherein the identified symmetry transformation group is a set of diffeomorphisms that act on a topologically closed and bounded region in space-time such that under transformation said region occupies the same points in space (Figures 2A and 2B).

43. Regarding claim 38, Calvert discloses:

A system according to claim 36 wherein each of the identified symmetry transformation groups corresponds to a plurality of shape families, each of which comprises a set of predicted critical points (column 1, line 30, "model blocks (cells)"; column 3, lines 45-62 "nodes").

44. Regarding claim 39, Calvert discloses:

A system according to claim 38 wherein the subdivisions are generated such that a shape family is selected from the plurality of shape families that corresponds to the identified symmetry transformation group, said selecting being based on closeness of correspondence between the identified critical points from the sampled data and the predicted critical points of the selected shape family (column 1, lines 42-44).

45. Regarding claim 40, Calvert discloses:

A system according to claim 39 wherein each shape family has an associated set of symmetry transformation group orbits, each orbit being associated with orbit information that specifies whether the orbit contains a predicted critical point and value of the Gaussian curvature of a point in the orbit, and wherein the orbit information from the set of symmetry transformation group orbits associated with the selected shape family is applied to the sampled data thereby

generating a unique specification of a shape from the selected shape family (column 3, lines 5-8; column 6, lines 57-58).

46. Regarding claim 41, Calvert discloses:

A system according to claim 40 wherein each of the plurality of subdivisions of shapes is generated by identifying a part of the uniquely specified shape that corresponds to the sampled data, and wherein the identified parts are assembled, thereby generating a representation of the earth structures (column 6, lines 57-60; Figure 1 **120**).

47. Regarding claim 42, Calvert discloses:

A system according to claim 36 as part of a system adapted to assist a decision making process relating to extraction of hydrocarbons from a hydrocarbon reservoir modeled by the processed earth model data (Figure 1, A system according to claim 36 wherein the sample data are acquired from the earth structures using seismic acquisition equipment, the storage system and the processing system are located at or near the location where the sample data are acquired, and the earth model processing system is located in one or more locations remote from the location where the sample data is acquired **106**).

48. Regarding claim 43, Calvert discloses:

A system according to claim 36 wherein the plurality of subdivisions are generated such that they are more numerically stable than third order or higher representation (Figures 2A and 2B).

49. Regarding claim 44, Calvert discloses:

A system according to claim 36 wherein the sample data are acquired from the earth structures using seismic acquisition equipment, the storage system and the processing system are located at or near the location where the sample data are acquired, and the earth model processing system is located in one or more locations remote from the location where the sample data is acquired (column 1, lines 10-17).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

50. Claims 15 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Calvert in view of US Patent 5,966,141, Ito (hereinafter Ito).

51. Calvert discloses a method for modeling earth data using a generated subdivision of shapes, using critical points of Morse theory including maxima and minima, but not saddle points.

52. Ito discloses using saddle points as one of the critical points for modeling three-dimensional shapes of Morse theory (Ito, column 10, lines 7-16 and 36-42).

53. Calvert and Ito are analogous art because they are both related to the field of modeling three-dimensional objects.

54. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to combine the saddle point modeling of Ito with the earth modeling of Calvert, motivated by the desire to secure "reasonably-shaped objects" (Ito, column 2, lines 41-45).

55. Regarding claim 15, Calvert and Ito teach:

A method according to claim 1 wherein the identified critical points are Morse theoretical height field critical points consisting of the following three types: minima, maxima (Calvert, column 14, lines 23-35) and saddle points (Ito, column 10, lines 7-16 and 36-42).

56. Regarding claim 16, Calvert and Ito teach:

A method according to claim 15 wherein said step of generating a plurality of subdivisions comprises applying a canonical homogeneous transform such that the number of parameters needed to uniquely describe a shape in the earth structure is minimized (Calvert, column 15, lines 13-19).

Additional References

57. US Publication 2002/0038201: Method of generating a hybrid grid of a heterogeneous formation crossed by one or more geometric discontinuities such as, for example, an underground formation where one or more wells have been drilled, or a fractured formation, by combining structured grids and non-structured grids in order to carry out simulations in accordance with a defined numerical pattern.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nithya Janakiraman whose telephone number is 571-270-1003. The examiner can normally be reached on Monday-Thursday, 8:00am-5:00pm, EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Paul Rodriguez can be reached on (571)272-3753. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Nithya Janakiraman
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August 17, 2007

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